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EXAMINER	
LEUNG, KA CHUN A	
ART UNIT	**PAPER NUMBER**
3747	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/535,693	ADLER, ROBERT	
	Examiner	Art Unit	
	Ka Chun Leung	3747	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *06 July 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *4-8 and 11* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *4-8 and 11* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

1. This Office Action is in response to Applicant's amendment filed on 07/06/2007.

Claim Rejections - 35 USC § 103

2. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

KOBAYASHI et al and HOPPIE

3. Claims 4 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over KOBAYASHI et al (US Patent 5,403,167) in view of HOPPIE (US Patent 4,448,176).

4. KOBAYASHI et al discloses a liquefied hydrogen pump (41) for a gas ignited engine (19) including a liquefied hydrogen fuel tank (1) and a heat exchanger (16). As noted in column 2, Line 53, "the hydrogen gas having a pressure of approximately 10 MPa [or 100 bar] is injected into the combustion chamber of the hydrogen ignited engine." Additionally, Figure 6 discloses the use of an injection valve (25) with a plunger (25A), valve spring (25B) and valve body (25C) connected to an injection pump (26) and reservoir (29) via tubes (27, 28). However, KOBAYASHI et al does not disclose the temperature that the hydrogen is heated to.

5. HOPPIE discloses a method of reducing ignition delay of fuels and in "hydrogen and/or carbon fuels used in combustion engines. HOPPIE cites in Column 1, Lines 44-46 that when fuel is preheated considerably above 500°K (~227°C), significant ignition

delay was found. Note that HOPPIE discloses using ranges from 500°K (~227°C) to 1000°K (~727°C) as shown in Figure 3.

6. Thus it would have been obvious to one of ordinary skill in the art to try a temperature range of 500°K to 1000°K as demonstrated by HOPPIE in attempt to provide a reduced ignition delay in engine of KOBAYASHI et al, as a person with ordinary skill has good reason to pursue the known option within his or her technical grasp. In turn, because the claimed method of the present invention contains methods predicted by the prior art, it would have been obvious to provide the method of heating hydrogen to at least 500°C prior to introduction into the combustion engine.

7. Specifically regarding Claim 4, the 1000°K (~727°C) upper range contemplated by HOPPPIE is greater than 500°C and is therefore "at least 500°C".

8. Specifically regarding Claim 8, hydrogen is stored in the tank (1) as liquefied hydrogen.

KOBAYASHI et al, HOPPIE, and WELCH et al

9. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over KOBAYASHI et al (US Patent 5,403,167) and HOPPIE (US Patent 4,448,176) as applied to Claims 4 and 8 above, and further in view of WELCH et al (US Patent 6,575,138).

10. KOBAYASHI et al (US 5,403,167). KOBAYASHI et al discloses a liquefied hydrogen pump (41) for a gas ignited engine (19) including a liquefied hydrogen fuel tank (1) and a heat exchanger (16). Additionally, Figure 6 discloses the use of an

injection valve (25) with a plunger (25A), valve spring (25B) and valve body (25C) connected to an injection pump (26)and reservoir (29) via tubes (27, 28). HOPPIE discloses that when preheated considerably above 500°K (~227°C), ignition delay can be reduced. However, neither reference discloses introducing the hydrogen fuel into the combustion chamber at pressures between 200 and 300 bar.

11. WELCH et al discloses a directly actuated injection valve for direct injection of gaseous fuel into the combustion chamber of an internal combustion engine comprising of an injection valve actuated by a solid magnetostrictive member (130). WELCH et al notes in the Background of the Invention:

> "with direct injection late in the compression stroke, a high-compression ratio can be maintained, maintaining efficiency. Further when the fuel that is directly injected comprises natural gas, propane, or hydrogen, the emissions of NO_x and particulate matter (PM) are significantly reduced."

Additionally as noted in Column 7, Line 15:

> "An advantage of the present injection valve is that it may be employed for late-cycle high pressure direct injection of fuels into internal combustion engines. For example, the present injection valve may be used to inject a gaseous fuel into the combustion chamber of an internal combustion engine at pressures of between about 2000 and 5000 psi (about 13.8 and 34.5 Mpa). The present injection valve may be employed to introduce liquid fuels into internal combustion engines at even higher pressures."

Moreover, in reference to the use of hydraulic actuators of prior art, WELCH et al states in Column 7, Line 53:

> "A disadvantage of active hydraulic actuators of this type is a lag time associated with moving the hydraulic fluid into and out of the hydraulic cylinder."

12. Thus it would have been obvious to a person having ordinary skill in the art at the time the invention was made to have provided hydrogen engine and pump of

KOBAYASHI et al with a directly actuated injection valve, in light of the teachings of WELCH et al, in order eliminate the lag time associated with hydraulic actuators and additionally enable late-cycle high-pressure direct injection for greater efficiency and reduced emissions. Please note that the cited pressure range of 2000 psi and 5000 psi is approximately 137.9 bar and 344.7 bar, respectively.

KOBAYASHI et al, HOPPIE, and WELCH et al and STONE

13. Claim 6, 7, and 11 are is rejected under 35 U.S.C. 103(a) as being unpatentable over KOBAYASHI et al (US Patent 5,403,167), HOPPIE (US Patent 4,448,176), and WELCH et al (US Patent 6,575,138) as applied to Claims 4 and 8 above, and further in view of STONE (US Patent 6,557,535).

14. KOBAYASHI et al (US 5,403,167). KOBAYASHI et al discloses a liquefied hydrogen pump (41) for a gas ignited engine (19) including a liquefied hydrogen fuel tank (1) and a heat exchanger (16). Additionally, Figure 6 discloses the use of an injection valve (25) with a plunger (25A), valve spring (25B) and valve body (25C) connected to an injection pump (26) and reservoir (29) via tubes (27, 28). HOPPIE discloses that when preheated considerably above 500°K (~227°C), ignition delay can be reduced. WELCH et al discloses a directly actuated injection valve for direct injection of gaseous fuel into the combustion chamber of an internal combustion engine comprising of an injection valve actuated by a solid magnetostrictive member (130). However, none of the above references disclose using exhaust steam to heat the hydrogen and in particularly KOBAYASHI et al does not distinctly disclose the type of

heat exchanger being used although it is well known in the art that heat exchangers transfer heats between two mediums (generally fluids).

15. STONE discloses a system and method for transferring heat from exhaust gasses to compressed gas fuel comprising of internal combustion engines (570, 580) connected to exhaust surfaces (550) for transferring heat to compressed gas fuel.

16. Thus it would have been obvious to a person having ordinary skill in the art at the time the invention was made to have provided the heat exchanger of KOBAYASHI et al with an exhaust heat surface arrangement, in light of the teachings of STONE, in order to assist vaporization of liquefied compressed gas fuel without the use of a liquid medium (e.g. coolant) which requires a significant amount of time to reach operating temperature.

Response to Remarks/Arguments

17. Applicant's arguments with respect to claims 4-8 and 11 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

18. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

19. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ka Chun Leung whose telephone number is (571) 272-9963. The examiner can normally be reached on 7:30AM - 4:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Stephen Cronin can be reached on (571) 272-4536. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

KCL
Ka Chun Leung
Examiner
Art Unit 3747

STEPHEN K. CRONIN
SUPERVISORY PATENT EXAMINER